REMARKS

In order to expedite the prosecution of the present application, the subject matter of Claims 4 and 7 has been incorporated into Claim 16. Additionally, Claim 16 has been amended to state that the orientation of the intermediate layer is at least 20°. Support for this amendment can be found in Figures 5A and 5B of the present specification. No new matter has been added.

Claims 4, 6, 7 and 10-18 have been rejected under 35 USC 102(b, e, or a) as being anticipated by Honjo et al. Applicants respectfully traverse this ground of rejection and urge reconsideration in light of the following comments.

The presently claimed invention is directed to an oxide superconducting wire made up of a metal substrate, an intermediate layer vapor-deposited by an ion beam-assisted deposition method on the metal substrate, a cerium oxide cap layer formed by a pulsed laser deposition method on the intermediate layer and an oxide superconducting film formed on the cap layer. The thickness of the intermediate layer is at least 10 nm and no more than 1,000 nm and the thickness of the cap layer is at least 50 nm and no more than 5,000 nm. The orientation of the intermediate layer is at least 20° and the orientation of the cap layer is no more than 10°.

As discussed previously, in the prior art, in order to obtain an oxide superconducting film having a high critical current density, it is required that the film have a high crystal orientation. As such, an ion beam-assisted deposited intermediate layer is typically formed between the metal substrate and an oxide superconducting layer. In order to provide the ion beam-assisted deposited intermediate layer with a thickness required for providing a sufficient orientation to the oxide superconducting film to achieve a desired critical current density, a large amount of time is required due to the low formation rate of the ion beam-

assisted deposited intermediate layer. Therefore, the prior art requiring a large amount of time has a low productivity.

In order to overcome the problems associated with the prior art, the present inventors discovered that by forming a cerium oxide cap layer having a certain thickness on the ion beam-assisted deposited intermediate layer by pulsed laser deposition, the orientation of the cap layer is greatly improved comparing that of the intermediate layer, the formation rate of the cap layer is much greater than that of the intermediate layer, and the formation of an oxide superconducting wire having a good orientation and a highly increased critical current density can be obtained in a shortened fabrication time. Since the ion beam-assisted deposited intermediate layer does not need to have a thickness exceeding 1,000 nm, the time for the formation thereof is greatly shorted and the time needed for the production of the superconducting wire is greatly shortened. Additionally, an increased critical density of an oxide superconducting layer to be formed on the cap layer can be obtained by decreasing the surface roughness and enhancing the orientation of the cap layer.

The oxide superconducting wire of the present invention allows the ion beam-assisted deposited intermediate layer to be made thinner and the pulsed laser deposited cerium oxide cap layer to be made thicker and yet still produce a superconducting film having a good crystal orientation. Although the cerium oxide layer can be provided on the ion beam-assisted deposited intermediate layer by sputtering, pulsed laser deposition results in the cerium oxide layer being formed faster and, due to the higher formation rate, the cerium oxide layer can be made at a much greater thickness in a shorter period of time, which results in improving the productivity of the product oxide superconducting wire.

The present invention is based on the discovery that if the cerium oxide layer is formed in at least a certain thickness on an ion beam-assisted deposited layer, even if the

thickness of the ion beam-assisted deposited layer is no greater than 1,000 nm, the resulting cerium oxide layer would have a good orientation, the cerium oxide cap layer can be formed by pulsed laser deposition which enables a rapid formation rate as high as 5,000 nm per minute and, as a result, even if the ion beam-assisted deposited intermediate layer is thinner, if the pulsed laser deposited cap layer of cerium oxide formed at a rapid formation rate is made thicker, the total film formation rate is considerably increased and gives a higher productivity. This allows an oxide superconducting film with a high critical current density to be formed on the cap layer.

An especially important discovery of the present invention is that if the cerium oxide layer is formed at least at a certain thickness on an ion beam-assisted deposited layer, even if the thickness of the ion beam-assisted deposited layer is no more than 1,000 nm, the resulting cerium oxide layer would have good orientation. Based on this discovery, the thickness of the intermediate layer and the cap layer are at least 10 nm and no more than 1,000 nm and at least 50 nm and no more than 5,000 nm, respectively, as required by the currently presented claims and the orientation of these layers are specified as at least 20° and no more than 10°. The cerium oxide layer having a reduced surface roughness and a higher orientation enables the formation of a superconducting film of a higher critical current density thereon. This is shown by the Examples and Comparative Examples in the present specification. It is respectfully submitted that the presently claimed invention is clearly patentably distinguishable over the Honjo et al reference.

Honjo et al discloses a tape-formed oxide superconductor comprising a tape-formed metal substrate of non-magnetism or weak magnetism and a high strength, a first intermediate layer where particles generated from a target are deposited on the metal substrate together with irradiation of ions from an inclined direction to the metal substrate, a second

intermediate layer comprising cerium oxide or yttrium oxide deposited by a sputtering method and an oxide superconducting layer formed on the second intermediate layer by a coating of metalorganic salts containing fluorine followed by thermal decomposition thereof.

Honjo et al discloses the first intermediate layer 3, ion beam-assisted deposited-YSZ, in Figure 1, as high c-axis and a-axis in-plane alignments or orientations to the substrate 2 and that the second cerium oxide intermediate layer 4 also has high c-axis and a-axis in-plane orientation according to the crystal orientation of the lower layer, i.e., the first intermediate layer 3. As discussed in the present application in paragraph [0018] and the Honjo et al reference in paragraph [0010], when a superconducting layer is formed using a substrate, the cerium oxide layer is formed as a buffer layer to suppress the reaction between the substrate and the constituents of the superconducting layer during the fabrication process. In Honjo et al, which uses a non-oriented substrate, the cerium oxide layer functioning as a buffer layer is chosen due to cerium oxide having a better crystallographic matching with the superconducting layer. The high orientation of the first intermediate layer 3 is given to the second intermediate layer 4 and this relayed high orientation results in a superconducting layer 5 with high c-axis and a-axis in-plane orientation according to the crystalline orientation of the lower layers 3 and 4. As discussed in paragraph [0021] of the present application, in order to form an ion beam-assisted deposited intermediate layer having adequate orientation, a thickness of about 1,000 nm is needed and a considerable amount of time is necessary to form this layer due to the slow film formation rate of ion beam-assisted deposition. This is shown by Figures 4, 5A and 5B of the present application.

Example 1 of Honjo et al discloses a tape-formed oxide superconductor wherein the full width of half maximum of a first intermediate layer (YSZ) having a thickness of 1 micron

is 8.80° while those of a second intermediate cerium oxide layer having a thickness of 0.5 microns and a YBCO superconducting layer having a thickness of 0.5 microns are 5.6° and 4.7°, respectively. In this arrangement of the respective layers, the YBCO superconducting layer is improved in its orientation. The first intermediate layer formed by ion beam-assisted deposition has a thickness of 1 micron in order to obtain a full width of half maximum (orientation) of 8.80° which is a much better orientation than the orientation of at least 20° of the intermediate layer of the present invention and requires a long formation time. As is evident from Example 1 of Honjo et al, this reference is concerned with the formation of a first intermediate layer having a high c-axis and a-axis in-plane orientation by increasing the thickness, as evidenced by the 1 micron thickness in Example 1, in order to obtain a superconducting layer having a high c-axis and a-axis in-plane orientation. However, the degree of improvement in the crystalline orientation of the resultant superconducting layer in Honjo et al is much smaller than that of the present invention. Honjo et al gives no disclosure regarding the provision of an improved superconducting product by improving the orientation of the second intermediate layer, which corresponds to the cap layer of the present invention, with a thinner first intermediate layer, which corresponds to the intermediate layer of the present invention without requiring a high orientation for the first intermediate layer, and tries to improve the superconductor from a different technical aspect from that of the claimed invention.

In contrast to the disclosure of Honjo et al, the present invention is based on the discovery that if the cerium oxide cap layer, which is to be compared with Honjo et al's second intermediate layer, is formed with at least a certain thickness on an ion beam-assisted deposited layer, which is to be compared with Honjo et al's first intermediate layer, the resulting cap layer has a good orientation even if the

thickness of the intermediate layer is no more than 1,000 nm. This means that a cap layer having a greater thickness of 50 to 5,000 nm can be formed with a very high orientation of no more than 10° onto an intermediate layer having a smaller thickness of from 10 to 1,000 nm and a lower orientation of at least 20°. For the formation of the superconducting layer of a high orientation, the present invention requires that a cap layer with a specified thickness formed as an underlying layer for the superconducting layer have a specified high orientation, which is similar to Honjo et al's second intermediate layer which is also required to have a high orientation. However, the intermediate layer of the present invention, which acts as a seed crystal layer for the cap layer, does not need to have a high orientation. In viewpoint of the crystal orientation, the intermediate layer of the present invention is clearly distinguishable from Honjo et al's first intermediate layer, which is required to have the high orientation as referred to being less than 10° in Example 1.

That is, the specified small thickness of 10 to 1,000 nm and orientation of at least 20° are enough for the intermediate layer of the present invention, although the high orientation and large thickness are required in Honjo et al's first intermediate layer. This is an important feature in the present invention. As illustrated by Figures 4, 5A and 5B of the present application, a high orientation needs an increased thickness. Since a high orientation is not required for the intermediate layer of the present invention, the formation time thereof is shortened. In contrast thereto, in Honjo et al, the first intermediate layer needs a longer formation time to achieve a sufficient thickness to provide high orientation. Therefore, the presently claimed invention clearly is basically distinguishable from Honjo et al.

Although the Honjo et al reference does not even present a showing of prima facie obviousness under 35 USC 103(a) with respect to the presently claimed invention, Applicants once

again with to reiterate that objective evidence is of record in the present application which is more than sufficient to distinguish the presently claimed invention over Honjo et al. On pages 12-19 of the present specification, Examples of the present invention and Comparative Examples are presented. Figures 4-8 of the present specification illustrate the results of these Examples and Comparative Examples. As shown in these figures, the present invention provides superior results in that the superconducting materials have a higher current density and exhibit more usefulness in practical application than the Comparative Examples. This clearly is surprising in light of the disclosure of Honjo et al and establishes the patentability of the presently claimed invention thereover. Moreover, as pointed out above, given the unexpectedly high film formation rate associated with the presently claimed invention, the economic effects alone also patentably distinguish the presently claimed invention over the cited reference.

The Examiner is respectfully requested to reconsider the present application and to pass it to issue.

Respectfully submitted,

Terryence F. Chapman

TFC/smd

FLYNN, THIEL, BOUTELL
& TANIS, P.C.
2026 Rambling Road
Kalamazoo, MI 49008-1631
Phone: (269) 381-1156
Fax: (269) 381-5465

Dale H. Thiel Reg. No. 24 323
David G. Boutell Reg. No. 25 072
Terryence F. Chapman Reg. No. 32 549
Mark L. Maki Reg. No. 36 589
Liane L. Churney Reg. No. 40 694
Brian R. Tumm Reg. No. 36 328
Steven R. Thiel Reg. No. 53 685
Donald J. Wallace Reg. No. 43 977
Sidney B. Williams, Jr. Reg. No. 24 949

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